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margined on one or both sides, 2.5 cm. long, 1 mm. broad, ovoid, all covered by the subtending bract.

The predominant feature of this species is its peculiar aspect, the stem being simple throughout to the top with its short peduncled spikes in the upper axils. Its nearest relative, *C. nitidum* Kit., is bushy-branched throughout; its leaves are narrowly linear and seldom more than 2 cm. long; its bracts are not imbricated and are narrower than the utricle, which is 2 mm. long and 1 mm. wide and winged, and the plant is almost glabrous.

C. hyssopifolium L. is profusely branched throughout, its leaves up to 6 cm. long and 4 mm. wide: its bracts are imbricated and its utricle is 3.5-5 mm. long, winged.

I have made out the characters of both of these species from European specimens in my herbarium. All the three aforesaid species are floriferous at the top only. Four other North American species belonging to the west, differ in being floriferous nearly to the base, and divaricately branched below. Two of these, moreover, have a wingless utricle.

The type specimen of *C. simplicissimum* is registered as No. 112 in my private herbarium. The plant was collected by me Aug. 26, 1890, on the shore of a lake several miles southeast of Barton, Pierce Co., North Dakota, as yet the only locality from which it is known to me.

Leeds, North Dakota.

The Laboratory Aquarium.*

J. A. NIEUWLAND.

The term aquarium in its broadest sense may be said to mean any vessel or receptacle for the development of aquatic life. It is most commonly applied to a tank or vessel for keeping the larger aquatic animals. In the latter sense very little reference will be made to the word in this discussion. Most of us may be best acquainted with the term as used for something to keep or domesticate fish and fishlike animals mostly for pleasure. I shall discuss the subject leaving out entirely this interpretation of the word, and confine myself entirely to the laboratory plant aquarium. However, much may have been written on animal aquaria, the literature on growth of plants, — and I refer especially to the microscopic forms,— is indeed meagre. The subject is, however, not without the greatest interest, especially to teachers in high schools and colleges, where competent laboratory work is done. No one will question the desirability of having live plant material for study, and pickled forms are used only when no other is available. Many of the lower forms of plants and animals can only be studied at their best in the motile live stage, and the reason students often carry away from the laboratory false notions is because the living moving plant is seldom seen or at least not as often as might be if the teacher realized that with a little extra effort, a marvelous interest could be stimulated in the student, with living plants. Much trouble is anticipated by the teacher in getting live specimens of the lower plants, especially the algae, but a little acquaintance with the habits of these too little known forms, will reveal the fact that much of the anticipated trouble is imaginary.

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*Paper read at the meeting of the Indiana Science and Mathematics Teachers, Richmond, Ind., March 5, 1910.

The plant aquarium is, however, absolutely necessary for a consistent study of microscopic plants in laboratory classes. Most of the laboratory work in cryptogamic botany has by custom or accident, or I know not what other reason, been relegated to the winter or early spring months, and part of this time at least no live specimens can be brought from the field, supposing even that the teacher knew just where to get any given plants. We must then naturally fall back upon attempts at domesticating these lower forms or, to a large extent, fall back upon the less satisfactory methods of using pickled material or prepared slides. The best teachers will never for habit study give students prepared slides when living material is at hand, and in this way, endless explanations about stains and other artificial things are avoided.

We may say after a number of years study of the best ways of developing plants in the laboratory for class use, that we must at the very outset take for granted that the plant aquarium is as different from the average animal aquarium as their respective inhabitants are, and the treatment accorded each in order to succeed is entirely different, in fact, in most cases quite opposite. Even the vessels that give best results in growing or domesticating aquatic animals are entirely different from the vessels that will give good results in growing plants. These vessels are invariably of glass, because allowing better penetration of light, which is, of course, more necessary to plants than animals. It is pretty well conceded that large square vessels made of separate plates of glass, cemented together by various mineral cements, are bst adapted for animals. At least such large several pieced vessels seldom explode, or crack.

Microscopic plants are susceptible to subtle influences of environment which are mostly unknown to us. The plant aquarium must be entirely of glass or other absolutely insoluble material like porcelain. Metals in contact with water in plant jars are fatal. Carbon dioxide present in small traces in water where living things are growing will dissolve minute quantities of otherwise insoluble metallic compounds, such as rust or oxides, and carbonates resulting in the formation of more or less soluble bicarbonates. Soluble metallic salts are ionized in water and therefore toxic. These substances may be almost imperceptible to analysis or at least but traces, but there is enough to prove fatal to plants. Even tap water may contain too much iron in solution. Many microscopic plants seem to be killed off by iron almost as easily as by lead, and this would seem all the more strange as iron is a necessary constituent of chlorophyl. Other plants appear to resist the action of iron only because they are able in some way to precipitate it from solution as a sulphide, and thus render it harmless. This can be easily shown in jars when Protococcoideae abound. The walls of the vessel become coated with a brownish layer which can easily be washed off with dilute acids when hydrogen sulphide comes off. The conjugatae, especially Spirogyra, do not seem to be able to precipitate iron nor resist its toxic action. Not being able to get rid of it they promptly die.

It is not true that larger aquaria are best for growing algae, though such are unquestionably most desirable for animal development. My experience of some years past is that the valuable plants for class demonstration are grown in glass vessels of medium size of less than a gallon capacity and not exceeding two gallons. The very best plants, and often in great variety, have been growing in vessels holding little more than an ordinary tumbler carefully covered to prevent evaporation and access of dust. I have at present in the laboratory the best variety of desmids I have ever seen in a laboratory culture. The vessel is shallow and wide and when full, holds not quite a pint of water. It has stood covered for months and contains innumerable specimens of Staurastrum, as also several species of Closterium and Cosmarium. These are constantly dividing.

Another jar has stood in the laboratory for about six months, having been filled with some Spirogyra and other conjugatae from the field, together with some sticks and debris in very small quantity. The Spirogyra has completely disappeared and the jar now contains, besides the prettiest Chroococcus I have seen, Oedogonium forming zoospores, Conferva with zoospores escaped, a very rare stage which I have never seen in the field. The plant is so common as to be a nuisance in spring, both in pools and in the laboratory. The small vessel has been systematically robbed of part of its contents for pickling and supplying other laboratories, and it still continues to develop new material of the old forms, and shows indications of producing new plants. This vessel is a round heavy glass box of the Bausch and Lomb make, and not more than four inches high and in diameter inside.

Some plants prefer shallow wide vessels, other grow best in deep vessels. I find that most prefer shallow ones, and when grown in deep ones develop generally only at the surface of the water. Fish globes are satisfactory but liable to crack and explode. Baloc beakers are cheapest and best because wide: those of five litres or less most convenient. They never explode, but are thin walled and must be handled carefully, especially when containing a soil or sand layer in the bottom. I have several twenty gallon aquaria but cannot remember a single really valuable plant or valuable stage of a common plant produced in them. They are excellent for preserving Utricularia, Salvinia, Lemna and larger aquatic plants. Utricularia is a valuable asset in the plant aquarium for trapping entomostraca, cyclops and other small animals in a plant culture. A plant immersed for a few days in the jar where these are present with valuable plants will soon reduce the animal devastators by catching them in their insectivorous bladders. They are then removed, as algae do not thrive with these higher plants present. Larger aquaria are especially good for growing small animals, such as entomostraca, snails, Fragania, Tubifex, planarians, Fairy-shrimps and hosts of others which live together harmoniously, or succeed one another. I have found that a larva stage of a dragon fly makes the best policeman for plant aquarium. When turned loose for a day or two destructive animals rapidly disappear. The larva lives long. I have had one do service for over a year. If left continuously in the plant jar its clumsy movements interfere with plant growth. There is no animal so destructive as the water snail. No plant culture will succeed when these are present and there seems no remedy, but to start without them. They must be picked out by hand one by one. Most of the animals mentioned, though valuable to the teacher of zoology for demonstration, are an intolerable nuisance in the aquarium. Animals should always be kept in separate jars and they always get by themselves sooner or later, after devouring all traces of plants.

As to the method of treatment that appears to be beneficial in developing microscopic plants in the laboratory, we may say in general, that it consists essentially in a process of domestication. This is as true of plants as of animals. All processes of domestication give results in proportion to the degree that they succeed in giving the captives conditions as near as possible to those enjoyed in the field where they develop as in their natural home, or as near as possible to the conditions in which the captives can be coaxed to accommodate themselves easily.

Quite a variety of methods of treatment of plants in the aquarium have been discussed already,* and I refrain from repeating such explanations, and will refer only to the most important in passing, trusting that such of my hearers as are especially interested will be able to consult the article in question. The most important fact, in developing plant and also animal life in the laboratory jars when desired is to have nearby in the field, places where desirable specimens are wont to develop. By going to such places one can in a few days or weeks obtain excellent laboratory material out of season by a method already referred to. Even in winter when little plant life exists or is dormant, or in the drought of summer when the pools are dried up, one can by taking a handful of soil or mud or debris from such places obtain laboratory cultures by simply putting this soil in the jar in small quantity and covering with water, and awaiting results. One must be cautioned to use a small amount of such mud, less than one-twentieth of the whole contents, or bacterial decay will destroy everything. It does not always happen that the specimens especially sought appear, but usually some others as valuable develop. Nor does the same material come from the mud taken from the same places and put in separate jars. Size of containers and other unknown influences cause variations. This method I have compared to the "forcing" of the higher plants before their regular time, and it is elsewhere explained with detail. It is also explained why direct transfer of mature and fully developed forms to the laboratory is not so satisfactory as the "forcing" method. Every teacher of botany or zoology realizes, I believe, the importance of having available localities for collecting material, but it has not been so fully understood how necessary this is for the success of the laboratory aquarium.

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*The American Midland Naturalist, Oct., 1909, Vol. I, pp. 82-87.

What are the conditions of the best collecting grounds in the field? I have often observed the tendency of collectors of water plants to betake themselves to large bodies of water, rivers and lakes, and ponds, and have very often seen them return hopelessly discouraged. If they persist they lose much valuable time, and finally give up collecting, thinking that their locality is barren. The best results are obtained from pools of water that are dried up part of the year. Wherever water constantly collects so as to be wholly submerged the year around, frogs, large water insects, aquatic and even fish will gain an access and destroy plant life. The plants can hardly develop their spores before being devoured by these enemies. Moreover, the period of rest during the dry season seems necessary to preserve the vitality of some algae. It is a matter of observation that few microscopic plants grow in large bodies of water, except Cladophora Hydrodictyon, Draparnaldia, Chaetophora, Chara. To prove how fish relish spirogyra, a small amount may be put in a globe with goldfish and it will rapidly be eaten.

Many collectors attempting laboratory cultures in aquaria have somehow got passessed of the idea that the water must be changed to prevent decay. I have thoroughly discussed this, but too much emphasis can not be laid on the matter. *Paradoxical as it seems, few plants can stand such treatment, and most will either die or be much retarded in development. A moment's reflection will tell us the reason. I have said that microscopic plants find great difficulty in adjusting themselves to surroundings, because being so small, they are benefitted or injured by insignificantly small factors, and it is just because they have great difficulty in accommodating themselves to new environment that we must refrain from putting them in a new condition by daily changes of water. In the second place, when plants are present in healthy condition, the very oxygen they give off is a check on bacteria, and when healthy, they can keep the water purer in this way than we can by changing it.* Water is not impure because green plants grow in it. Moreover, green plants are put in fish aquaria in order to keep the water oxygenated.

When it is necessary to bring fully developed plants into the laboratory aquarium from the field, they should be allowed to remain in the water taken from their habitat, unless there is a chance of a new generation developing. Some algae may stand the changes of water once, many promptly rebel and die. We may then take the chances of getting a new culture from the spores produced as the plants disappear. In any case, by keeping all cultures several months before throwing out a jar which seems to be unproductive for a time, we often find some remarkable growths later. Absolute decay by bacteria indicated by changes of color and offensive odors as also complete choking up of the contents by oscillatoria are the signs that the contents of a jar are beyond the stage of future usefulness.

The reason why the "forcing" method is the best is the following. Mud collected in the field in dry or adverse conditions, even in winter, contains spores which seem in the resting stage eagerly awaiting a chance to develop. They will come out even under comparatively unfavorable conditions or will then make a special effort to accommodate themselves to even a possible existence. They will even develop in the laboratory in winter, because the change from the field to warm room is not unlike the advent of spring to them, especially if the light is strong. Resting stages contained in the mud can more easily resist adverse conditions. Plants and animals go into the resting stage or form hypnospores for this very reason of resisting adverse conditions.

Plant aquaria should be covered with a plate glass, both to keep out dust and also to prevent rapid evaporation. Water will evaporate slowly despite all efforts. This must be replaced little by little. Adding too large an amount at one time may prove fatal. The addition is also necessary to keep up the available food salt of the plants. Addition of water must never exceed one-fifth of the contents of the aquarium. The salts used by plants and present in all natural water may be also replaced by adding Sach's tablets, as these contain the proper proportion of mineral salts necessary to their development.

Good light, in fact very strong, and direct sunlight is necessary to many algae. The average material develops well, however, in diffuse sunlight. I have tried for some years to keep up cultures of Euglena, Pandorina Haematococcus or Sphaerella in the laboratory but without success, and have finally found that my failures were due to want of sunlight. These plants, I have already shown, grow best in midsummer in places where organic matter is decomposing in direct blistering sunlight, e. g. the wallows of pigs, pools around watering places, and near barns. I have once seen a basin of water containing manure at the bottom and covered one-half an inch deep with the Englena. This pool about 30x60 feet square was covered by a layer of the purest culture of Euglena. I have even found in the motile stage. It would be a pretty problem of mathematics to attempt to calculate the number of organisms present when we reflect that the animal, as you may wish to call it, is only 30-40 microns long. (Less than 1-500 of an inch.

Our professor of zoology can obtain and keep vegetative euglenae at will, by putting some crumbs of bread in a jar of stagnant water. Bacteria and mould will come out only in small quantities because it decays in direct sunlight. He obtained Haematococcus and even the rare stages of conjugation and daughter cell formation, by taking debris from a place where such were found in the field and adding rain water. His laboratory is, however, on the south side of the building where he has direct sunlight most of the day.

Microscopic animals, on the other hand, seem to develop better on diffuse sunlight and in large vessels. I have obtained some specimens of Zoothamnia, fragania, fairy-shrimps, and spongelike animals that were quite rare, or were not reported from this part of the country, and they develop in great numbers. Hydras, both the small green species (*H. viridis*) and the larger chlorophylless one (*H. fusca*) come in great abundance in late spring and early summer, both in large and medium sized aquaria and are usually found together, the latter disappearing first as its food gives out, the former chlorophyl bearinf remaining for months.

When water is too alkaline, or contains too much lime in solution, a few plants of chara should be introduced into the aquarium. The plant is called Stonewort, because of large quantities of calcium carbonate present in it. Plants introduced in summer grow readily and fruit well the oospores remain in good condition till germinating in spring.

Tapwater is used for the aquarium unless it contains too much iron. The water must be allowed to run some time before filling a jar, as water standing in pipes, especially iron or lead pipes, is dangerous. Water contains iron when it leaves a brown spot, where it drips constantly.

An inch of sand in the bottom of vessel is sometimes beneficial, when animals are present it is objectionable as they find a refuge, then bury themselves and can with difficulty be removed. Soil is sometimes good but often serves as a hiding place for worms like Tubifex, and this might be remembered by those who want animal rather than plant forms. When soil is taken from the natural habitat of the plant it is an advantage, but when taken in larger proportion than one-tenth of the contents of the jar, will usually grow more animals than plants.

In transfering algae from the field to the laboratory only a very small amount of material should be put in each jar, or decay will result rapidly. Though algae appear sometimes in aquaria in dense masses leaving little room in a jar, it must be remembered that they do so only after they have made their environment favorable by counteracting all adverse influences. Large quantities of algae can never be kept in the laboratory unless they appear of their own accord. Conjugatae are especially difficult. Ulothrix is out of the question as are all forms that thrive in running water.

The stage of congugation of Spirogyra is seldom developed in the laboratory, possibly because of insufficient sunlight. Nearly all conjugatae except *Spirogyra nitida* conjugate in Spring. (April, May.) Desmids conjugate but never abundantly in captivity. Diatoms and zoospores of Vaucheria develop best from material brought into the laboratory in winter. The former become extremely active when brought from the cold outside to the warmth of the laboratory. The latter seem to be affected by the change as if spring came. They produce numerous zoospores in a few days. Nearly all algae appear periodically though the periods are not fixed, and therefore the contents of a jar not containing active bacteria nor infested with oscillatoria should not be thrown out too soon. Algae are at times slow in coming out, but great varieties follow one another once the conditions are favorable. A recent example in my laboratory will illustrate this point. Some Spirogyra was put into a jar last summer. It contained some Mougeotia and Zygnema also, besides a small amount of grass blades and debris. The vessel was put aside in strong light and almost forgotten till one day a month ago, a deposit of plankton was found in the bottom. Examination revealed a small amount of the aforesaid algae but large quantities of zoospores of conferva and some oedgonium in similar stage. Chroococcus was abundant later. This jar of not over one and one-half pint capacity contained the best stages of these algae I have seen. The jar was robbed systematically and is still developing. Protococcus forms are just beginning to appear.

Laboratory cultures are usually better than field cultures, not only because they are, generally speaking purer, but because they afford continuous study of successive stages. In the field even, one is often tempted to do superficial cursory examinations of larger areas rather than intensive continual observation of one small pool. Needless to say, the latter method brings best results. We shall be astonished what a great variety of specimens we may obtain from one small pool, if we watch it carefully and long enough. I obtained the largest amount of my best and rarest material from some drain holes along a railroad only a quarter of a mile of its length. The laboratory jar is always at hand and ready for examination, hence most convenient for intensive work. Even when we have a good field for collecting, the aquarium is an indispensible adjunct to class work, and ever for research. Ecology and habits of plants and animals cannot be studied as well in the field as in the transparent jar. I will cite but a simple example. The omnivorous worm, Tubifex, is an inhabitant of pools periodically dry, and in sluggish streams it is often so abundant that the bottoms are colored red by the large number. There has been considerable comment whether this worm, Tubifex, (so called because it builds a case or tube around itself), has its anterior in the mud or out of it. These animals are constantly swaying back and forth in rhythmical motion, to cause water currents. They are often several inches long, about the thickness of a thread, and the approach of any enemy causing a disturbance in water near, is sufficient to make them retreat instantly into the ground and no trace of them is seen until quite is restored. Some will invariably dig down at the edge of the aquarium and their anatomy from one end to the other may thus be studied through the glass with a magnifier, and without in the least disturbing them. Sound waves do not seem to effect them, though sound travels in water and when the vessel is struck a sharp resounding rap, they are not affected as some other small aquatic animals are. Some zoologists have maintained that these worms are imbedded "head first" in the mud, others claim their heads or anterior portion is extruded, and I am told that the matter has not been settled. Now it does matter very much whether a worm wants to stand on its head or otherwise, but it is very easy to settle the problem viewed in the aquarium, though in the field none seem to have been able to decide. A few moments observation will show to the veriest tyro that the food which these worms are continuously eating is seen passing upwards through their transparent bodies and finally cast out above, causing in part, the formation of the tube around them, from which they get their name. I have asked many students, some mere beginners, and all could solve the difficulty in a few seconds of observation.

This is only one instance to show that if we wish to become better acquainted with the lower forms of life we must bring them near to us and study their ecology. The difficulties of field study are such that little has been done heretofore with algae ecology. The aquarium for microscopic plants may in the future solve some of these problems, besides being a help and convenience for class work.

SUMMARY OF REQUISITES FOR SUCCESS WITH THE LABORATORY AQUARIUM.

1. Use the right kind of jar, i. e., smaller one-pieced glass vessels for plants and larger ones for animals; shallow and wide aquaria for plants, deeper ones for animals.
2. Good light. Diffuse daylight is generally best. Direct and even strong sunlight for algae grown in summer.
3. Avoid access of dust and minimize evaporation.
4. Avoid presence of mineral salts and alkalinity of water.
5. Never change water nor add more than one-fifth of contents of the jar.
6. Advantages of the "forcing" method should be realized. Therefore, contents of an aquarium should be kept several months unless bacteria or oscillatoria or animals invade it. Give the spore stages a chance to appear.
7. Remove all animals as much as possible from plant aquaria.
8. Study the ecology of specimens in the field, and give the specimens in the laboratory jars as much as possible their native outdoor habitat, e. g., regarding light intensity, depth of water, kind of water, etc.
9. Find a good collecting ground preferably pools, dry part of the year, in order to replenish the laboratory jars, and do intensive rather than extensive field work.
10. Interest, perserverance and patience especially at the start.

Our Birds in October and November.

BROTHER ALPHONSUS, C. S. C.

The reason why the writer failed to see three species of birds on one day only in October can be accounted for in two of the instances. On the 16th he did not visit a certain piece of lowland overgrown with brush, where he always found the Goldfinch, and on that day he did not see the bird elsewhere. The Song Sparrow was not seen on the 29th, the first time it was not found since its arrival on March 6th. Up to the date of its departure, on Nov. 8th, the bird was seen irregularly. I cannot account ɪor not seeing the Snowbird, unless it be